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EFFECTS OF VIRTUAL AND AUGMENTED REALITY TECHNOLOGIES ON THE GLOBAL ECONOMY*Abstract:*

This research is aimed to study relatively new virtual and augmented reality technologies to understand how the global economy can benefit from these disruptive technologies. Paper provides an estimation of the possible economic impact worldwide for the retail e-commerce industry associated with augmented reality technology for 2021-2024.

Keywords:

Virtual / Augmented reality technologies, global economy, retail e-commerce

Emerging technologies change the way people live, business operate facilitating, speeding up, systematizing many processes. Most of the existing studies in virtual / augmented reality (next - VR/AR) field are aimed at investigation of peoples' feelings associated with VR / AR usage in order to describe in which direction hardware and software developers should work to enhance increase the level of technology adoption. This research contributes to the plunge into VR / AR technologies and its market to understand how it can be used for gaining economic benefits for the economy.

The goal of the research is to analyze and evaluate possible global economic impact associated with implementation of VR / AR technologies, particularly for the retail e-commerce industry. It is hard to predict the future outcomes for the global economy. But for example, iPhone / iPad was firstly released in 2007 / 2010 by Apple and nowadays it has a wide scope of application. Smartphones and tablets are now essential in many industries and have increased global economic productivity.

Virtual and augmented reality technologies are disruptive technologies, which potentially can impact a lot on the global economy. The explosive growth of the market began in 2015 with the release of VR headset Oculus Rift CV1, growth has increased thanks to launch of Pokemon Go what led to the mass understanding of what AR is among people [1]. Figure 1 shows the key events in the market development. Nowadays the market continues to grow exponentially. The global VR/AR market is projected to account for a revenue of \$1.274 billion in 2030 with CAGR 42.9% [2].

Application of VR / AR hardware and software is possible literally in all industries – from simpler ones such as retail, travelling up to high complex industries – healthcare, engineering, military. The development of the market is highly dependent on the level of adoption in society, and it is one of the key challenges nowadays – to make VR / AR product visible, affordable and usable as far as possible in many directions. To resolve this challenge, all VR/AR ecosystem members (Figure 2) should help to decide two other challenges: to decrease costs of devices and to increase the hardware/software quality. But there is a high level of uncertainty of how widespread the technology will be, how ecosystems will evolve based on the implementation of VR/AR yet.

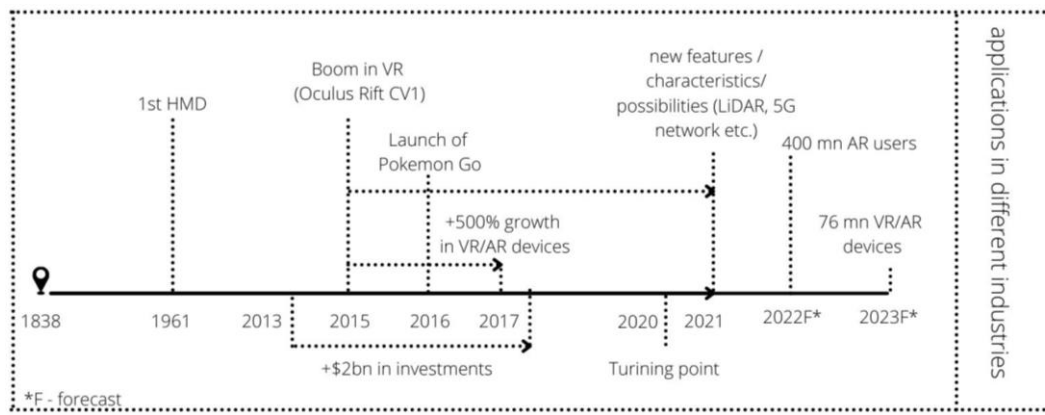


Figure 1 – Brief timeline of VR / AR market development

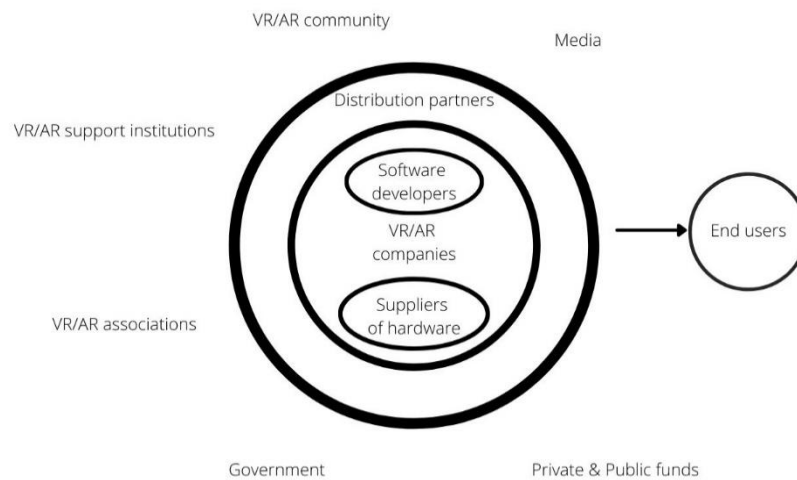


Figure 2 – VR/AR ecosystem

Goldman Sachs reported 9 industries [3], which currently use VR/AR more often than others: video games, live events, video entertainment, retail, real estate, education, healthcare, engineering, and armed forces. The key factors in assessing the most potential use cases were based on the potential markets in terms of users, what current challenges can be solved today with the help of technology in particular industries, possibility of changing revenue streams within the adoption of the VR/AR and the last factor is potential revenue by the software or subscription by 2025.

Based on the key challenges of the market, considering the current development of VR/AR market and also complexity matrix of industries (incorrect / inaccurate usage can lead to serious losses/damages - a complex industry, otherwise - an easy one) I have created complexity matrix of the implementation/usage VR/AR technologies in industries (Figure 3). In my opinion, not counting the videogame industry, than lower device quality requirements for the industry, then the probability is higher these industries will drive consumer awareness and demand, and consequently lead the market to growth. As for B2B sector, this corresponds to the high requirements of the equipment and the complex interaction of user input. Such sectors need a lot of investment to become more publicly available, but currently not all companies are ready to invest. According to the Perkins Coie analysts [4], 69% of potential investors' main concern is the slow adoption of AR among consumers. Also 58% of them also consider the absence of an established market as an obstacle for new investments.

The coronavirus pandemic has had a significant impact on almost all sectors of the global economy and has forced companies to change business models in order to survive, and consumers to change behavior in order to continue using and enjoying familiar things, activities despite the new format. The covid-19 situation can help to adopt technologies into businesses faster, showing advantages of using it for both businesses and consumers. Healthcare, retail and e-commerce sectors

showed the highest demand in AR during pandemic, they are key drivers of the AR market growth nowadays [5].

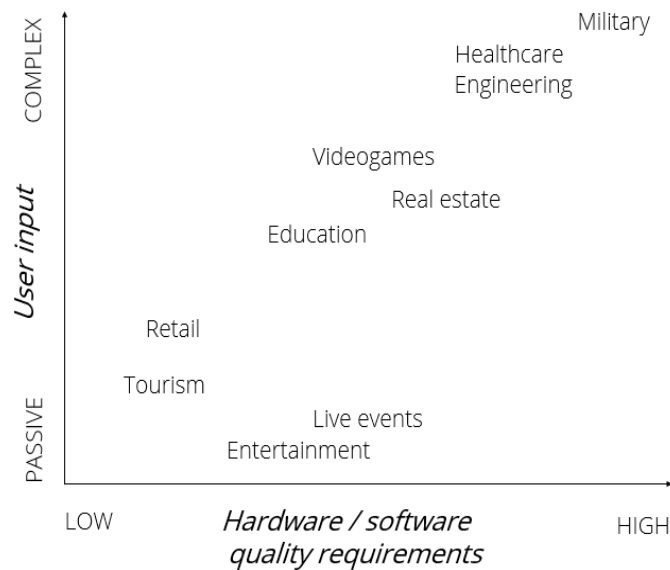


Figure 3 – Complexity matrix of the implementation/usage of the VR/AR technologies in industries.

In recent six-month companies are publishing more and more news about implemented innovations in VR/AR. The researchers distinguish among recent significant innovative events that will drive industry growth are the introduction of the 5G network and the introduction of LiDAR by Apple in iPhone. Both technologies will allow users to create more efficient and immersive experiences by increasing the quality of picture and data transfer rate.

I decided to analyze possible global economic e-commerce impact associated with implementation of VR/AR technologies worldwide because of the growing demand for AR technology by retail businesses (try on tools, augmented catalogs, live events), as well as their increasing adoption among e-commerce buyers. AR is more likely to use among the consumers to purchase in comparing with VR, because of low level of device requirements, easier access by smartphones, ability to use it everywhere with internet connection. Augmented reality technology is a quite new innovation and it is difficult to predict the possible impact of using it in any industries.

To assess the possible economic impact of AR on retail e-commerce industry, I use two approaches – «conservative» and «comparable», that was used by Laurits Christensen [6] for evaluating the global economic impacts associated with virtual and augmented reality. These methods can be quite controversial because economic impact is assessed by the forecast of the VR/AR headset sales and utilization of smartphones and tablets as similar technologies to VR/AR and in the future can be substituted. In my research, the «conservative approach» estimates the retail e-commerce impact associated with AR in the form of that each an active user of AR will make an e-commerce purchase at least once in a year. The «comparable approach» estimates the additional AR impact on e-commerce sales that could be realized as the result of higher level of adoption AR among the internet users.

For the «conservative approach», to estimate the potential economic retail e-commerce impact I assess the revenue for the next 4 years that can be generated based on two sources of data: projected number of AR active users [7] and average order value (next - AOV) [8]. I consider the possible number of active AR users for the next 4 years based on projections (2021-2024).

As for the «comparable approach», it estimates an additional impact to the «conservative approach», considering the possible impact of AR mass adoption among internet users on retail e-commerce sales, which is represented by multiplier (next – M) of the share that additional impact of total spent in e-commerce by 1 person per year (Formula 1). This additional impact of retail e-

commerce represents economic activities related to the ecosystem that has developed around internet users, including, for example, AR application development, increased in internet network speed, technological advances, and productivity improvements.

$$M = EI / (AOV * ANT), \quad (1)$$

where EI - estimated per 1 internet user impact; ANT - average number of transactions in e-commerce per 1 person per year.

For assessing the estimated per 1 internet user impact, I am going to consider a dynamic specification of retail e-commerce sales in 22 countries during the period 2015-2019. This period was chosen based on the assumption about that the boom in studied technologies began in 2015. In the research are included countries with the highest potential to gain economic impact from AR using in e-commerce in the nearest future. The distribution of countries by level of socio-economic development is uneven. The sample is largely made up of developed countries, with a much smaller number of developing countries. The sample is represented by 16 developed countries, 6 – developing. The empirical model for retail e-commerce sales (Formula 2) is build based on evidence by Debesh Bhowmik [9] and Inma Rodríguez-Ardura [10].

$$\ln RES_{i,t} = \alpha_1 + \alpha_2 * \ln UI_{i,t} + \alpha_3 * GDP_{pci,t} + \alpha_4 * ICT_{exi,t} + \alpha_5 * UNEM_{i,t} + \alpha_6 * FBS_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where $\ln RES_{i,t}$ is the natural logarithm of retail e-commerce sales (billions USD); $\ln UI_{i,t}$ is the natural logarithm of internet users (% of population); $GDP_{pci,t}$ is gross domestic product per capita (constant US\$); $ICT_{exi,t}$ is ICT goods export (% of total goods exports); $UNEM_{i,t}$ is unemployment rate (total, % of total labor force); $FBS_{i,t}$ is fixed broadband subscription per 100 people; α_k is a coefficient for the corresponding variable (k - sequence number at the coefficient); $\varepsilon_{i,t}$ is the element of the error which varies over group and time.

The multiplier of the share that additional impact of total spent in e-commerce by 1 person per year is equal to 0,0125. Applying the multiplier to estimated AR retail e-commerce revenue from the «conservative approach» in an additional estimated economic impact of AR technology, I got \$171 billion of sales in 2024 (Figure 4) in case of the development of the AR e-commerce ecosystem. Projected sales of \$ 171 billion represent 4% of the current e-commerce retail market.

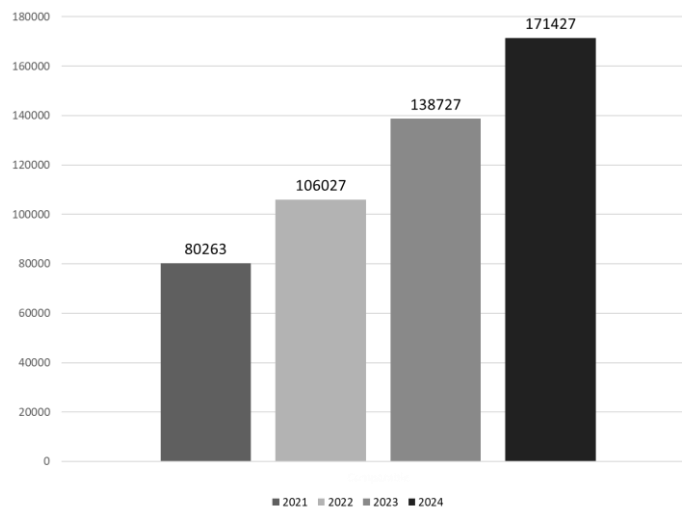


Figure 4 – Estimated economic retail e-commerce impact worldwide associated with AR, billions USD

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